Columbia/Snake Rivers Main Stem Temperature TMDL
Factoring in the Tributaries

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[NOTE: Figures 1 and 2, flow chart, and appendices deleted from this comment draft to reduce file size only! Comments of DAE embedded in bold bracketed text]

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Introduction

Background

The States of Idaho, Oregon and Washington and EPA Region 10 are working in coordination with the Columbia Basin Tribes to develop Total Maximum Daily Loads (TMDL) for Temperature and Total Dissolved Gas (TDG) on the main stems of the Columbia and Snake Rivers. A TMDL for a water body is a document that identifies the amount of a pollutant that the water body can receive and still meet Water Quality Standards (WQS). It also allocates responsibility for reductions in the pollutant load that are necessary to achieve WQS. It does this by assigning wasteload allocations to the point sources of pollution and load allocations to the nonpoint sources.

EPA is taking the lead for the technical analysis and development of the temperature TMDLs on both rivers. In so doing, EPA will determine the total amount of heat that the main stems can receive from point and nonpoint sources of pollution and from natural sources before they begin to violate WQS for temperature. This TMDL is aimed at only the main stems of the rivers. Our intent is to develop the waste load allocations for point sources and the load allocations for nonpoint sources that affect heat loading directly to the main stems of the Columbia and Snake Rivers.

The tributaries of the Columbia and Snake Rivers carry heat load to the main stems. Some or most of the tributaries currently exceed WQS for temperature and will require the development of TMDLs. The states are developing those TMDLs with an ultimate goal of achieving WQS for Temperature on all of the tributaries before they enter the Columbia or Snake River. These TMDLs will address the heat sources to the tributaries. These tributary TMDLs are on different schedules than the main stem TMDL and many of them will be completed after the main stem TMDLs.

This paper describes how tributary heat loads will be assigned in the main stem TMDLs. It first discusses the relative importance of tributaries to water temperature in the main stem, then outlines the overall approach for assigning loads, discusses the rationale for that approach in detail and finally describes the technical approach for assigning the loads in detail.

Relative Importance of the Tributary heat loads to achieving WQS in the Main Stem

The impact of advected sources of heat such as tributaries on the temperature of the Columbia River after mixing is determined by the ratio of the advected energy from the tributary to the advected energy from the main stem. **[This is true only imeadiately after, that is downstream of mixing. The extent to which tributary loads are communicated further downstream is very dynamic.]** The energy **[heat load?]** of the tributary and the main stem is a factor not only of their temperatures but also their flows. If the temperatures are within a few degrees of each other, flow will be the important factor determining the effect of the tributary on the main stem.

Except for the Snake River and the Willamette River, the tributaries to the Columbia River are relatively very small compared to the Columbia. **[What about the Clearwater? I would not consider it small.]** The following tables compare the average discharges of a number of tributaries to the average discharges of the Columbia and Snake Rivers.

Table 1: Average Flows of Selected Columbia River Tributaries Compared to Columbia River Flows*

Tributary Average Discharge	Nearby Columbia Average Discharge
Okanagan RM 17 - 3145 cfs	Rocky Reach Dam - 116,200 cfs
Wenatchee RM 21.5 - 3094 cfs	Rocky Reach Dam - 116,200 cfs
Yakima RM 29.9 - 3569 cfs	Priest Rapids Dam - 119,800 cfs
John Day RM 20.9 - 2095 cfs	The Dalles Dam - 192,100 cfs
Deschutes RM 1.4 - 5845 cfs	The Dalles Dam - 192,100 cfs
Snake RM 9.7 - 55,090 cfs	The Dalles Dam - 192,100 cfs
Willamette RM 84 - 24,090 cfs	Quincy, OR - 253, 300 cfs

* From Hubbard, etal, 1999 and Zembrzuski, Jr, etal, 1999

Table 2: Average Flows of Selected Snake River Tributaries Compared to Snake River Flows*

Tributary Average Discharge	Nearby Snake Average Discharge
Clearwater RM 11.6 - 15430 cfs**	Anatone, WA - 36270 cfs
Grande Ronde RM 45.3 - 3101 cfs	Ice Harbor Dam - 55,090 cfs
Tucannon RM 7.9 - 173 cfs	Ice Harbor Dam - 55,090 cfs

Palouse RM 19.6 - 614 cfs	Ice Harbor Dam - 55,090 cfs
Walla Walla RM 18.2 - 576 cfs	Ice Harbor Dam - 55,090 cfs

* From Brennan, etal, 1999 and Zembrzuski, Jr, etal, 1999 ** Mean Annual Flow Clearwater

In the report "Columbia River Temperature Assessment: Simulation Methods (EPA, 1999) **[I would like to get a copy of this]** an assessment of the impacts of tributaries on the main stem Columbia and Snake River temperatures was conducted using the RBM 10 Water Quality Model. In this assessment, the model was used to compare two scenarios in order to estimate the effects of tributary temperatures on main stem temperatures:

- simulate main stem river temperatures for existing conditions; and
- simulate main stem river temperatures for existing conditions except that tributary temperatures are constrained so that they never exceed 16 deg C. **[Should list the tribs this assumption was applied to, e.g all those in Tables 1 & 2, or more? Also, I assume by never exceed that you are talking maximum daily maximum (MDMT) was limited to 16°C. Was this accomplished by cliping only the peaks where they exceeded 16°C, or where temperature on average lowered enough so that the MDMT never exceeded 16°C?]**

The model was used to predict the frequency of exceedances of 20 deg C under the two scenarios. Tables 3 and 4 list the means of the frequency of exceedances of 20 deg C. Constraining the tributary temperatures to 16 deg C had little effect **[looking at table 3 I see absolutely <u>no difference</u> between frequency of excursions between existing conditions and tributaries contrained, is this right?]** on the frequency and magnitude with which main stem temperatures exceeded 20 deg C. The exceptions to this were that the Clearwater River has a significant effect on the Snake River and the Snake River has a significant effect on the Columbia. The Willamette River was not included in this study. **[I see no evidence of this in Tables 3 or 4]**

Table 3: Frequency of Exceedance of 20 deg C in the Columbia River Under Existing Conditions and with Tributaries Constrained to 16 deg C.

Hydrologic Project	Existing Conditions Frequency of Excursion			Tributaries Constrained to 16 deg C Frequency of Excursion		
Columbia R at Grand Coulee	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Rock Island	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Priest Rapids	<0.01	0.01	0.03	<0.01	0.01	0.03
McNary	0.02	0.07	0.12	0.02	0.07	0.12
John Day	0.12	0.16	0.20	0.12	0.16	0.20
Bonneville	0.15	0.19	0.22	0.15	0.19	0.22

Table 4: Frequency of Exceedance of 20 deg C in the Snake River Under Existing Conditions and with Tributaries Constrained to 16 deg C.

Hydrologic Project	Existing Conditions Frequency of Excursions			Tributaries Constrained to 16 deg C Frequency of Excursions		
Snake R. at Anatone	0.13	0.16	0.20	0.13	0.16	0.20
Lower Granite	0.09	0.14	0.19	0.09	0.14	0.19
Little Goose	0.10	0.15	0.20	0.10	0.15	0.20
Lower Monumental	0.10	0.16	0.20	0.10	0.16	0.20
Ice Harbor	0.11	0.16	0.20	0.11	0.16	0.20

Synopsis of Methodology for Establishing Loads for Tributaries

Heat load allocations will be established for the tributaries at their mouths **[Again a list of these would be nice, that is if it is different from those listed in Tables 1 & 2. If not, just refer to Tables 1 & 2].** Due to the size and complexity of the Columbia Basin and the over all TMDL process in the basin we will not allocate loads to sources in the tributaries. This paper discusses the rationale for this approach to assigning loads to tributaries in detail.

Additionally, the WQS for most of the tributaries have numerical criteria and narrative criteria. Essentially the narrative criteria say that when natural water temperature exceeds the numerical criteria, the natural temperatures plus a small prescribed increase due to human activities will be the applicable numerical criteria. So, the numerical temperature targets for many tributary streams will not be known until the natural water temperatures are identified. In most cases natural temperatures will not be identified until temperature TMDLs are completed. This paper, therefore, also describes the technical approach that will be used to assign the heat loads at the mouths of the tributaries when the narrative criteria apply.

Rationale for Assigning Tributary Heat Loads at the Mouths of the Tributaries:

TMDL development involves the allocation of waste loads or loads to all sources that ultimately effect the attainment of WQS in the water body for which the TMDL is being developed. Wasteload allocations address all point sources and load allocations address background and nonpoint sources. Due to the size and complexity of these TMDLs, tributaries will be treated as nonpoint sources and given a load allocation. It is expected that the states will develop TMDLs that address the individual sources on each tributary per previously agreed upon TMDL schedules.

Size, Complexity and Schedule of the TMDL Work Load In the Columbia Basin

Figure 1 shows the entire Columbia River Basin. The Columbia/Snake River Basin occupies over 259,000 square miles. It includes most of the States of Oregon and Washington, and nearly all of Idaho. It extends into British Columbia, Montana, Wyoming, Utah and Nevada.

Figure 1: The Columbia River Basin

[Figure deleted to reduce file size of this comment draft]

Figure 1 provided by the Bureau of Reclamation **[Don't need two figure captions!]**

Figure 2 highlights the portion of the Columbia and Snake Rivers for which the temperature TMDLs are being developed. The TMDL will cover over 900 river miles of the two main stems. Idaho has 1 tributary to the portion of the Columbia or Snake Rivers for which this TMDL is being developed. Oregon has 34 sub-basins and Washington has 38 sub-basins that drain into the Columbia/Snake subject to this TMDL.

The complexity of this river basin for developing a TMDL comes in part from the size of the basin, but also from the multiple jurisdictions in the basin, and the diverse land uses and developments in the basin. The entire basin is international and interregional. The portion covered by this TMDL is interstate and affects 12 sovereign tribes.

Figure 2: Portions of the Columbia and Snakes Rivers Covered by this TMDL

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The portion of the Columbia Basin covered by this TMDL supports diverse agricultural uses including irrigated agriculture, aquaculture, forestry, mining, transportation including navigation, urban development, hydroelectric power, and commercial fishing.

In size alone, the Columbia Basin represents a majority of the TMDL work load in Region 10 and logically has to be broken into sub-basins for TMDL development. The jurisdictional issues and the complexity of land uses and development are also more manageable at the sub-basin level. For these reasons we will not allocate loads in the tributary sub-basins but instead will treat the tributaries as non-point sources and establish loads at the tributary mouths. The states will then complete the tributary TMDLs on already developed schedules.

TMDL Priorities in the Columbia Basin

As part of the TMDL development process, states are required by the Clean water Act to establish a priority ranking for waters requiring a TMDL (40 CFR 130.7). The priority is to take into consideration the severity of pollution and the uses to be made of such waters. The states' priority ranking are included in Appendix A. The priorities of the Columbia and Snake main stems vary among the states. The States and EPA decided to develop the Columbia/Snake main stem temperature TMDL at this time for the following reasons:

1. Twelve stocks of Pacific Salmon in the Columbia and Snake Rivers are listed as threatened or endangered under the Endangered Species Act. The Sturgeon is also listed in the Columbia Basin. The effects of temperature and dissolved gas on salmon are well documented as important limiting factors in the recovery of salmon in the Columbia and Snake Rivers. Further, the federal government has Tribal trust and treaty responsibilities to ensure that Tribes have adequate salmon resources for cultural uses.

2. The Federal Columbia River Power System Action Agencies are consulting with the

National marine Fisheries Service and the Fish and Wildlife Service on the impacts of the Hydro-power system on salmon and sturgeon. The Biological Opinions resulting from the consultation highlights the importance of water quality in the recovery of salmon and call for the development of a Water Quality Plan to achieve WQS.

3. Many of the licenses to operate hydro-power facilities at the non-federal dams in the Columbia Basin are expiring in the next 10 years. The Federal Energy Regulatory Commission will be making decisions on re-licensing of those facilities, involving the NEPA process and extensive public input. The States have a role under the Clean Water Act to certify whether or not the FERC license will comply with State WQS. EPA has the WQS certification responsibility for any hydro-power projects that potentially impact waters on Indian reservations and EPA has responsibility to review and comment on the NEPA documents that are developed in the re-licensing process. The Tribes also play an important role in the re-licensing process, consulting with FERC to ensure that treaty and trust responsibilities are met in the new license. The TMDLs will be important for the States, Tribes and EPA to participate in the re-licensing process.

4. EPA and the States decided that it makes sense to address the main stems of the Columbia and Snake Rivers at one time. This requires coordination of the State TMDL schedules. Oregon's 2001 due date for completion of the Columbia River TMDLs was one of the reasons developing the Columbia/Snake River TMDLs now.

For these reasons, the States and EPA decided to develop the Columbia ans Snake River main stem TMDLs at this time. All heat sources to the main stems will be addressed through wasteload and load allocations but the tributaries will be treated as nonpoint sources and load allocations will be established for them. This will require reliance on future TMDLs for attainment of tributary allocations.

Technical Approach for establishing Loads at the Mouths of Tributaries

Initially, we will calculate the heat load that each tributary can carry during critical conditions **[might want to say when this is, if known, or else how it will be determined]** and still be in compliance with WQS. It is possible for a tributary to be in compliance with WQS but still carry sufficient pollutant load above natural loads to contribute to WQS violations in the main stem. This is especially true if the tributary standards are less restrictive than the main stem standards. In these cases loads may be allocated to the tributaries that are more stringent than required to attain WQS in the tributary. **[Even if that would require the tributary be colder than is natural??]**

State Water Quality Criteria

Appendix B summarizes the applicable water quality criteria for temperature from Oregon, Idaho and Washington and the Colville Tribes. The Oregon citeria state "...no measurable surface water temperature increase resulting from anthropogenic activities is allowed" above specified numerical thesholds. The numerical thresholds vary with water body and season as summarized in Appendix B. A measurable surface water temperature increase is defined as 0.25 degrees F.

The Washington temperature criteria vary by river reach as summarized in Appendix B. As an example, the criteria for the Columbia River reach along the Oregon/Washington border is ..."temperature shall not exceed 20 degrees C due to human activities. When natural conditions exceed 20 degrees c, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3 degrees C; nor shall such temperature increases, at any time, exceed 0.3 degrees C due to any single source or 1.1 degrees C due to all such activities combined."

The Colville Tribes' WQS apply to Lake Roosevelt and the upper Columbia River from Lake Roosevelt to the Okanagan River. They state "The temperature shall not exceed 16 degrees C due to human activities. Temperature increases shall not at any time exceed t=28/(T+7). When natural conditions exceed 16 degrees C no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 degrees C. ...t represents the permissible temperature change across the dilution zone; and T represents the highest temperature in this water classification outside of any dilution zone."

The WQS for temperature in Idaho have numerical criteria as summarized in Appendix B. In the Snake River the criteria for cold water biota is " Water Temperatures of twenty-two (22) degrees C or less with a maximum daily average of no greater than nineteen (19) degrees C."

[Idaho also has a natural background condition clause in its water quality standards, in section 58.01.02.070 Application of Standards. Paragraph 06 in that section reads:

06. Natural Background Conditions. Where natural background conditions from natural surface or ground water sources exceed any applicable water quality criteria as determined by the Department, that background level shall become the applicable site-specific water quality criteria. Natural background means any physical, chemical, biological, or radiological condition existing in a water body due only to non-human sources. Natural background shall be established according to procedures established or approved by the Department consistent with 40 CFR 131.11. The Department may require additional or continuing monitoring of natural conditions. (4-5-00)

Idaho strongly objects to EPA's interpretation of this rule as being different in effect than the rules of Oregon or Washington with regard to natural conditions or non-anthropogenic exceedance of numeric criteria being a violation of water quality rules.]

So for Oregon, Washington and the Colville Reservation, it is necessary to estimate natural conditions in order to establish numerical targets for the TMDL. **[And in Idaho as well, unless you want ot be real dumb about this.]**

Establishing Heat Loads for Tributaries

We will follow a number of iterative steps to establish the heat load allocations for the tributaries (see flow chart).

1. If a TMDL has been completed for a tributary stream, the load established in that TMDL will be the starting point for establishing the tributary load for the main stem TMDL. **[Does this imply, as I think it does, that a tributary TMDL would be adjusted downward if need be to bring about mainstem compliance with criteria? I want it perfectly clear here what is being contemplated.]** Compare that load to other loads coming to the main stem reach. If load reductions are needed to achieve WQS in the main stem reach, allocate a load reduction to the tributary based on consideration of its contribution to the heat load of the main stem, the relative magnitude of human activities in the tributary basin and other considerations of the interagency TMDL steering committee.

2. If a TMDL has not been completed for a tributary stream characterize temperature conditions at the mouths of the tributaries during critical conditions.

3. If temperatures do not exceed the numerical temperature criteria for the tributary, the numerical criteria will be the target temperatures for the TMDL. Calculate the load carried by the stream at that temperature. Compare that load to other loads coming to the main stem reach. If load reductions are needed to achieve WQS in the main stem reach, allocate a load reduction to the tributary based on consideration of its contribution to the heat load of the main stem, <u>the relative magnitude of human activities</u> in the tributary basin and other considerations of the interagency TMDL steering committee. **[I assume that the text I've underlined above means that the lower Columbia TMDL would specify cooling of the tributary only if there are anthropogenic sources to be controled that would reduce heat load at the mouth.]**

4. If the tributary temperatures characterized in step 2 exceed the numerical temperature criteria in the WQS, then the natural water temperatures of the tributary may be the applicable WQS. However, the natural water temperatures will not be characterized until a TMDL is done for the tributary stream. The following procedure will be followed to establish the load of the tributary. **[Seems to me that we will have to answer this question of natural thermal potential here and under step 3 as well. In other words, regardless of whether tributary temperatures currently are or are not above numeric criteria, we would not want to prescribe a heat load to them that is impossible to acheive. Or does that not matter, would it simply trigger an adjustment of the mainstem TMDL?]**

   - Calculate the loads of the tributary at the actual temperature from step 2.

- Compare that load to other loads coming to the main stem reach. If load reductions are needed to achieve WQS in the main stem reach, allocate a load reduction to the tributary based on consideration of its contribution to the heat load of the main stem, the relative magnitude of human activities in the tributary basin and other considerations of the interagency TMDL steering committee.

- The TMDL will indicate that these loads are for the achievement of WQS in the main stem. When the TMDL for the tributary is developed it may require smaller heat loads if required to meet the WQS in the Tributary.

Summary

- Load allocations will be assigned to the tributaries.

- If TMDLs have been completed for a tributary, the resulting loads will be used in the main stem TMDL unless it ~~has been~~ is determined during the mainsten thermal load analysis that greater load reductions are needed. **[I think these edits make it more clear, or do I mis-understand?]**

- If no TMDL has been developed for a tributary and its water temperature during critical conditions is less than the threshold in state WQS, that threshold will be used to develop an initial load. The initial load will be adjusted downward if it is a significant **[what is significant? 0.3°C?]** contributor to nonattainment of WQS on the main stem. **[This adjustment needs to be constrained to be no less than natural conditions]**

- If no TMDL has been developed for a tributary and its water temperature during critical conditions is greater than the numerical criteria in state WQS, the temperature at critical conditions will be used to develop an initial load. The initial load will be adjusted downward if it is a significant contributor to nonattainment of WQS on the main stem. **[Ditto comments in bullet above]**

[Basically the question I have is "What happens to the mainstem TMDL, if in latter analysis of a tributary it is shown the allocation given it by the mainsten TMDL can not be met?" We need a contingency plan to revisit the mainstem TMDL should it be found a tributary is not able to meet the mainstem allocation upon closer examination during a tributary TMDL. This contingency should be anticipated, specified in the Lower Cloumbia TMDL.]

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